VERIFICATION OF TRANSLATION

I, Malcolm Gesthuysen, B.Sc., translator to Messrs. Taylor and Meyer of 20 Kingsmead Road, London SW2 3JD, England, state the following:

I am fluent in both the English and German languages and capable of translating documents from one into the other of these languages.

The attached document is a true and accurate English translation, to the best of my knowledge and belief, of the description, claims and abstract of the accompanying certified copy of German Patent Application 196 04 840.0, filed on 12th February 1996.

I state that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true.

Signature: __________

Date: 4 December 2000

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FEDERAL REPUBLIC OF GERMANY

Certificate

On 12th February 1996 Messrs. David Finn of Pfronten/Germany and Manfred Rietzler of Marktoberdorf/Germany filed a Patent application entitled

"Process and device for wiring a wire conductor on a substrate and also substrates produced by such means"

at the German Patent Office.

The attached papers are a true and accurate reproduction of the original documents for this patent application.

The application has provisionally been given the International Patent Classification symbols H 05 K and H 04 R at the German Patent Office.

Munich, 27th August 1998

On behalf of the President of the German Patent Office

(signature)
Brand

Filing number: 196 04 840.0

PROCESS AND DEVICE FOR WIRING A WIRE CONDUCTOR ON A SUBSTRATE AND ALSO SUBSTRATES PRODUCED BY SUCH MEANS

The present invention relates to a process according to the preamble to Claim 1 and also to a device according to Claim 14 that can be used for implementing the process.

From DE 44 10 732 A1 a process is known for wiring a wire-shaped conductor on a substrate, wherein an ultrasonic connecting instrument is employed for the purpose of fixing the wire-shaped conductor on the substrate. At the points of connection of the wire conductor to the surface of the substrate the ultrasonic connecting instrument that is employed in the known process brings about a "rubbing" of the wire conductor into the surface of the substrate. This rubbing presupposes a vibratory movement, induced by ultrasound, of the wire guide parallel to the wiring plane - that is to say, to the surface of the substrate - such as is known from the conventional use of so-called ultrasonic bonders for connecting a bond wire to the terminal area of a chip unit. In this connection the ultrasonically induced movement directed parallel to the surface of the substrate in the course of the "rubbing process" that has been described has proved to be advantageous for producing a connection by material closure between a wire conductor and the terminal area of a chip unit.

Since the principle of the connection between the wire conductor and the substrate is based on countersinking the cross-section of the wire conductor at least partially in the surface of the substrate or bringing it into close contact with the latter, it is obvious that an ultrasonically induced movement of the wire guide directed substantially parallel to the surface of the substrate does not contribute directly to the countersinking or close contacting. Rather, in the known process the countersinking is effected by reason of an increase in temperature brought about by a static pressure load on the wire guide, which is superimposed on the ultrasonically

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induced transverse movement of the wire guide back and forth - that is to say, on the aforementioned "rubbing process".

The object underlying the present invention is to propose a process for wiring a wire-shaped conductor on a substrate and a device that is suitable for this purpose, by means of which the wiring of the wire-shaped conductor in the surface of the substrate can be carried out still more effectively.

This object is achieved by means of a process having the features of Claim 1 and by means of a device having the features of Claim 14.

With the process according to the invention the wire conductor is subjected to the action of ultrasound in a direction transverse to the wiring plane, and the transverse movement of the wiring device induced by the action of ultrasound is superimposed on the wiring movement extending in the wiring plane.

The superimposition of the wiring movement together with the transverse movement countersinking the cross-section of the wire conductor in the surface of the substrate or bringing it into close contact with the latter enables continuous operation of the wiring device, so that the wire conductor is capable of being connected to the surface of the substrate not only in the region of definite connecting points but over any length without the actual wiring movement having to be interrupted in the process. Furthermore, the transverse movement induced by ultrasound proves to be particularly effective during the at least partial countersinking or the close contacting of the cross-section of the wire, since the movement induced by the ultrasound extends in the direction of sinking and not

transversely thereto, as is the case with the process described in the introduction.

It proves to be particularly advantageous if the transverse movement induced by ultrasound takes place along a transverse-movement axis that is variable as regards its angle in relation to the axis of the wiring movement. By this means it is possible to adjust the transverse-movement axis so as to conform to the special requirements. Thus it is possible in the case where an elevated temperature of the wire conductor to be countersunk is desired, possibly depending on the substrate material, to align the transverse-movement axis more in the direction of the wiring-movement axis, in order in this way to obtain a greater longitudinal-force component which acts on the wire conductor and which as a consequence of the associated rubbing of the wire guide on the wire conductor results in heating of the same. In order to obtain a rate of sinking of the wire conductor in the surface of the substrate that is as high as possible it can be advantageous to align the transverse-movement axis at an angle of 45° to the wiring-movement axis, in order to achieve a shearing effect in the substrate material that is as great as possible.

In order to vary the depth of penetration of the wire conductor into the surface of the substrate, the ultrasonic frequency and/or the angle between the axis of the wiring movement and the transverse-movement axis may also be varied.

With respect to a connecting process following the wiring of the wire conductor in the form of a wire coil on the surface of the substrate for the purpose of connecting the wire conductor to terminal areas of a chip unit it can prove particularly advantageous if the final region of the coil and the initial region of the coil are guided via a recess in the substrate, so that the subsequent connection

of the terminal areas of a chip unit to the initial region of the coil and to the final region of the coil can be effected without impairment caused by the substrate material.

In order to enable an alignment of the initial coil region and of the final coil region that is as rectilinear as possible between opposite edges of the recess it is advantageous to interrupt the exposure of the wire conductor to ultrasound in the region of the recess.

An interruption of the exposure of the wire conductor to ultrasound also proves to be advantageous for the purpose of crossing an already wired section of wire in the crossing region, whereby in addition the wire conductor in the crossing region is guided in a crossing plane that is spaced from the wiring plane. This ensures that a crossing of wire conductors becomes possible without it being possible for damage to occur in the process as a result of collision of the wire conductors, which could possibly result in destruction of the insulation of the wire conductors.

The use of the process described above in various embodiments has also proved to be particularly advantageous for the manufacture of a card module having a substrate, a coil which is wired on the substrate and a chip unit which is connected to the coil. In this case a coil having an initial coil region and a final coil region is formed on the substrate in a wiring phase by means of the wiring device, and in a subsequent connection phase a connection to terminal areas of the chip unit is brought about between the initial region of the coil and the final region of the coil by means of a connecting device.

As a result of the integration of the wiring of the wire conductor on the substrate into a process for the

manufacture of a card module on the basis of any substrate that permits an at least partial penetration of the wire conductor into the surface of the substrate or close contact of the wire conductor against the surface of the substrate, this application of the process enables the formation of card modules that are easy to handle and that are used as semifinished products in the manufacture of chip cards. With a view to completion of the chip card the card modules are then, as a rule, provided on both sides with laminated surface layers. Depending on the configuration and thickness of the substrate material, the connection between the wire conductor and the substrate material can be effected via a more or less positive inclusion of the cross-section of the wire conductor in the surface of the substrate - for instance, when the substrate is formed from a thermoplastic material - or by means of a predominantly close-contact fixing of the wire conductor on the surface of the substrate, for instance by bonding the wire conductor together with the surface of the substrate. The latter will be the case, for example, when the substrate material is a fleece-type or woven-fabric-type support.

Particularly in the course of the manufacture of paper bands or card bands such as are used, for example, for identifying luggage, the connection of the wire conductor to the surface of the substrate via a layer of adhesive between the wire conductor and the surface of the substrate has proved to be advantageous. In this case the wire conductor comes into close contact against the surface of the substrate in a peripheral region via the layer of adhesive. If the wire conductor is provided with a suitable surface coating, for example baking lacquer, the layer of adhesive may be formed from the surface coating.

With the application of the process as described above, the use of a thermocompression process for connecting the

initial region of the coil and the final region of the coil to the terminal areas of the chip unit has proved to be particularly effective.

It is possible for a further increase in the effectiveness of the application of the process as described above to be achieved if a plurality of card modules are manufactured at the same time in such a way that in a feed phase a plurality of substrates arranged collected together in a yield are supplied to a card-module production device comprising a plurality of wiring devices and connecting devices and subsequently in the wiring phase a plurality of coils are formed simultaneously on substrates arranged in a row, then in the connection phase a plurality of chip units are connected via their terminal areas to the coils and finally in a separation phase a separation of the card modules from the composite yield takes place.

Furthermore, an application of the process for the manufacture of a rotationally symmetrical coil bobbin has proved advantageous wherein the wire-shaped conductor is wired on a substrate taking the form of a winding support and rotating relative to the wiring device. For the purpose of establishing the relative rotation there is the possibility either to cause the substrate to rotate about its longitudinal axis in the case of a stationary wiring device or, in the case of a stationary substrate, to move the wiring device on a trajectory about the longitudinal axis of the substrate, or even to superimpose the two aforementioned types of motion.

The aforementioned application of the process enters into consideration in particular for the manufacture of a moving coil of a loudspeaker unit that is integrally connected to a vibrating diaphragm.

According to another application of the process the process serves to wire a wire-shaped conductor on a substrate by means of a wiring device that subjects the wire conductor to ultrasound with a view to manufacturing a ribbon cable, whereby a number of wiring devices corresponding to the number of cable conductors desired is arranged transversely in relation to the longitudinal axis of a ribbon-shaped substrate and a relative movement between the substrate and the wiring devices takes place in the direction of the longitudinal axis of the substrate.

The wiring device for wiring a wire-shaped conductor on a substrate by means of ultrasound comprises a wire guide and an ultrasonic generator, whereby the ultrasonic generator is connected to the wire guide in such a way that the wire guide is stimulated to execute ultrasonic vibrations in the direction of the longitudinal axis.

It proves to be advantageous for the design of the wiring device if the latter is equipped with a wire-guidance capillary which at least in the region of a wire-guide nozzle extends in the wire guide parallel to the longitudinal axis. In this manner it is ensured that in the region of the wire-guide nozzle the axial advancing movement of the wire conductor is not impaired by ultrasonically induced transverse loads. Rather the ultrasonic loading extends in the longitudinal direction of the wire.

For the purpose of introducing the wire conductor into the wire guide, however, it proves to be advantageous if the wire guide comprises, spaced from the wire-guide nozzle, at least one wire-feed channel extending obliquely in relation to the longitudinal axis of the wire.

With a view to avoiding ultrasonically induced transverse loads on the wire conductor in the region of the wire-guide

nozzle it also helps if the ultrasonic generator is arranged coaxially with respect to the wire guide.

Cost-effective production of a relatively large number of card modules becomes possible by means of an embodiment of the device that comprises:

a yield supply station for supplying a plurality of substrates arranged in a yield,

a wiring station with a plurality of wiring devices arranged in a row transverse to the production direction,

an assembly station with at least one assembly device for equipping the individual substrates with a chip unit and

a connection station with at least one connecting device for connecting the chip units to an initial coil region and to a final coil region of the coils which are formed on the substrates by the wiring devices.

Variants of the process and also of the device for implementing the process and embodiments of substrates produced in accordance with the process and provided with a wire conductor are elucidated in more detail below on the basis of the drawings. Illustrated are:

Fig. 1 a schematic representation of the wiring of a wire conductor on a substrate by means of ultrasound;

Fig. 2 an electron micrograph for the purpose of representing a wire conductor embedded in the substrate;

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Fig. 3 a wiring device for wiring a wire conductor by means of ultrasound;

Fig. 4 a wire conductor wired in coil form on a substrate with ends guided away via a recess in the wire conductor;

Fig. 5 a coil configuration that is varied in comparison with **Fig. 4** with wire ends guided away via a substrate recess;

Fig. 6 the placement of a chip unit in the substrate recess represented in **Fig. 5**;

Fig. 7 the connection of the wire ends represented in **Fig. 5** to terminal areas of the chip unit which is inserted in the recess;

Fig. 8 a production device for the manufacture of card modules;

Fig. 9 the wiring of a wire conductor by means of ultrasound on a rotationally symmetrical winding form;

Fig. 10 a moving coil of a loudspeaker unit manufactured by means of ultrasonic wiring on a cylindrical winding form;

Fig. 11 a longitudinal-section representation of a ribbon cable equipped with wire conductors.

Fig. 1 shows, in a schematic representation, the wiring of a wire conductor 20 on a substrate 21 by means of a wiring device 22 with a wire guide 23 which is subjected to the action of ultrasound.

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The wiring device 22 represented in **Fig.** 1 is designed to be capable of being displaced along three axes and is subjected to the action of ultrasound which stimulates the wire guide 23 to execute oscillating transverse movements (arrow 24), which in the example represented in **Fig.** 1 are aligned perpendicular to a wiring plane 28 spanned by lateral edges 25, 26 of a substrate surface 27.

For the purpose of wiring, the wire conductor 20 is moved out of a wire-guide nozzle 30 while executing a continuous advancing movement in the direction of the arrow 29, whereby at the same time the wire guide 23 executes a wiring movement 29 which extends parallel to the wiring plane 28 and which in **Fig.** 1 can be retraced from the course of the wire-conductor section already wired on the substrate 21. On this wiring movement, which extends in the region of the front lateral edge 25 in the direction of the arrow 29, the oscillating transverse movement 24 is superimposed. This results in an impinging or impacting of the wire-guide nozzle 30 on the wire conductor 20 which is repeated in rapid succession corresponding to the ultrasonic frequency, leading to a compression and/or displacement of the substrate material in the region of a contact point 32.

Fig. 2 shows in a sectional representation, which corresponds roughly to the course of the line of intersection II-II indicated in **Fig. 1**, the embedded arrangement of the wire conductor 20 in the substrate 21. The substrate represented here is a PVC sheet, whereby for the purpose of embedding the wire conductor 20 the wire conductor is subjected via the wiring device 22 to, for example, an ultrasonic power output of 50 W and an ultrasonic frequency of 40 kHz. The contact force with which the wire-guide nozzle 30 is caused to abut the substrate surface 27 may, in the case of the aforementioned substrate material, lie in the range between 100 and 500 N.

As is evident from the representation according to **Fig. 2**, in a test which was carried out by adjusting the aforementioned parameters an embedding of the wire conductor 20 into the substrate 21 was obtained substantially by virtue of a compression of the substrate material in a compression region 33 of the substrate material which here is crescent-shaped.

The wiring principle represented in **Fig. 1** can be universally employed. For instance, departing from the use elucidated in detail below in connection with the manufacture of a card module (**Figs. 4** to **7**), the principle may also find application in connection with the wiring of wire coils in plastic casings, for instance in order to form an aerial for a cordless telephone (mobile phone) or in order to form a measuring coil of a sensor.

Fig. 3 shows the wiring device 22 in an individual representation with an ultrasonic generator 34 which is arranged coaxially with respect to the wire guide 23 and is rigidly connected to the latter in a connecting region 35. Overall the wiring device 22 represented in **Fig. 3** is of rotationally symmetrical construction. The wire guide 23 comprises a central longitudinal bore 36 which in the region of the wire-guide nozzle 30 merges with a wire capillary 37 which in comparison with the longitudinal bore 36 has a narrowed diameter that is matched to the diameter of the wire conductor 20. The wire-guidance capillary 37 serves primarily to be able to align the wire conductor exactly in the wiring plane 28 (**Fig. 1**).

In the embodiment example represented in **Fig. 3** there are arranged to the side of the wire guide 23, above the wire-guide nozzle and leading into the longitudinal bore 36, two wire-feed channels 38, 39 which extend obliquely downwards in the direction of the wire-guide nozzle 30. The wire-feed channels 38, 39 serve for lateral introduction of the

wire conductor 20 into the wire guide 23, so that the wire conductor 20, as represented in **Fig. 3**, extends laterally on a slant into the wire-feed channel 38, through the longitudinal bore 36 and, guided out of the wire-guidance capillary 37, through the wire guide 23. In this case the multiple arrangement of the wire-feed channels 38, 39 permits selection of the wire-supply side of the wire guide 23 that is most favourable in the given case.

As is further evident from **Fig. 3**, the wire-guide nozzle 30 is of convex construction in the region of a wire outlet 40 in order to enable a deflection of the wire conductor 20 that is as non-damaging as possible in the region of the contact point 32 (**Fig. 1**) or in the region of the wire outlet 40 in the course of the wiring operation represented in **Fig.** 1.

Although not represented in any detail in **Fig.** 3, the wire guide 23 may be equipped with a wire-severing instrument and a wire-advancing instrument. In this case the wire-severing device may be directly integrated into the wire-guide nozzle 30. **Fig. 4** shows a wire conductor 20 which, for the purpose of forming a coil 41 which in this case takes the form of a high-frequency coil, is wired on a substrate 42. The coil 41 here has a substantially rectangular configuration with an initial coil region 43 and a final coil region 44 which are guided away via a window-shaped substrate recess 45. In this case the initial coil region 43 and the final coil region 44 are in parallel alignment with a main coil strand 46 which they accept between them in the region of the substrate recess 45. In the course of the ultrasonic wiring of the wire conductor 20 already elucidated in principle with reference to **Fig. 1** the ultrasonic loading of the wire conductor 20 is interrupted while the latter is being guided away via the substrate recess in the course of the wiring operation, in order on the one hand to ensure no impairment of the

alignment of the wire conductor 20 in an unrestrained region 47 between the recess edges 48, 49 located opposite one another and on the other hand in order to rule out stressing of the connection between the wire conductor 20 and the substrate 42 in the region of the recess edges 48, 49 by tensile stresses on the wire conductor 20 as a consequence of ultrasonic loading.

Fig. 5 shows, in a configuration that is modified in comparison with **Fig. 4**, a coil 50 with an initial coil region 51 and a final coil region 52 which are guided, angled in relation to a main coil strand 53, into an interior region of the coil 50. The coil 50 is arranged on a substrate 55 which comprises a substrate recess 56 in the interior region 53 of the coil 50. In order to be able to guide away both the initial coil region 51 and the final coil region 52 via the substrate recess 56, in the case of the configuration represented in **Fig. 5** the final coil region 52 has to be guided away beforehand in a crossing region 57 via the main coil strand 44. In order in this case to prevent damage to or a partial stripping of the wire conductor 20, similarly as in the region of the substrate recess 56 the ultrasonic loading of the wire conductor 20 is interrupted in the crossing region 57. Furthermore, the wire guide 23 is slightly raised in the crossing region 57.

Fig. 6 shows, in a view of the substrate 55 corresponding to the course of the line of intersection VI-VI in **Fig. 5**, the placement of a chip unit 58 in the substrate recess 56, wherein terminal areas 59 of the chip unit 58 are caused to abut the initial coil region 51 and the final coil region 52.

Fig. 7 shows the subsequent connection of the terminal areas 59 of the chip unit 58 to the initial coil region 51 and to the final coil region 52 by means of a thermode 60

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which under the influence of pressure and temperature creates a connection by material closure between the wire conductor 20 and the terminal areas 59, as an overall result of which a card module 64 is formed.

In the case of the chip unit 58 represented in **Figs. 6** and **7** it may also be a question, as in all other remaining cases where mention is made of a chip unit, either of an individual chip or of a chip module which, for instance, comprises a chip which is contacted on a chip substrate or even a plurality of chips. Furthermore, the connection represented in **Figs. 6** and **7** between the coil 50 and the terminal areas 59 is not restricted to the connection to one chip but applies generally to the connection of electronic components comprising terminal areas 59 to the coil 50. In this case it may be also a question, for example, of capacitors.

Furthermore, it becomes clear from **Figs. 6** and **7** that the substrate recess 56 is so dimensioned that it substantially accepts the chip unit 58. With a view to simplifying the alignment of the terminal areas 59 of the chip unit 58 in the course of the placement of the chip unit 58 preceding the actual contacting, the chip unit 58 may be equipped on its contact side 61 comprising the terminal areas 59 with an alignment aid 62 which here is constructed in the manner of a bridge. The alignment aid 62 is dimensioned so as to correspond to the spacing a which the initial coil region 51 and the final coil region 52 have from one another in the region of the substrate recess 56 (**Fig. 5**).

Fig. 8 shows a production device 63 that serves for the manufacture of card modules 64 that are used as semifinished products in the manufacture of chip cards. The card modules 64 manufactured by means of the production device 63 here have, by way of example, the structure represented in **Figs. 5**, **6** and **7** with, in each instance, a

coil 50 and a chip unit 58 arranged on a common substrate 55.

The production device 63 represented in **Fig. 8** comprises five stations, namely a feed station 65, a wiring station 66, an assembly station 67 and a connection station 68 as well as an extraction station 69.

In the feed station there is supplied to the production device 63 a so-called yield 70 which exhibits in a common composite a plurality of substrates 55 - here for representational reasons only twenty - which are connected to one another via points of separation which are not represented here in any detail. The yield 70 is supplied by means of a transport instrument 71 to the wiring station 66 which comprises at a portal 73, which extends transversely in relation to the production direction 72 and is capable of being displaced in the production direction 72, four identical wiring devices 22 arranged in a row. The wiring devices 22 are supplied with the wire conductor 20 via four wire-conductor coils 74. For the purpose of forming the coil configurations represented by way of example in **Fig. 5**, the wiring devices 22, which are capable of being displaced along the portal 73, are displaced appropriately in the wiring plane 28 (**Fig. 1**).

After wiring of the wire conductors 20 corresponding to the coil configuration represented in **Fig. 5**, the yield 70 with the coils 50 formed thereon is moved on further to the assembly station 67. In the present case the connection station 68 is combined with the assembly station 67 in such a way that, on a portal 75 which is capable of being displaced in the production direction 72, both an assembly device 76 and a connecting device 77 are arranged so as to be capable in each instance of being displaced in the longitudinal direction of the portal 75. In this case the assembly device 76 serves for extraction of chip units 58

from a chip-unit reservoir 78 and for subsequent placement of the chip units 58 in the manner represented in **Fig. 6**. The connecting device 77 serves to bring the terminal areas 59 of the chip units 58 into contact with the coil 50, as represented in **Fig. 7**.

After assembly and contacting, the yield 70 is moved on further into the extraction station 69. Here an extraction of the yield 70 takes place with subsequent separation of the substrates 55, or firstly a separation of the substrates 55 - that is to say, a dispersion of the composite yield - and subsequently the extraction of the individual substrates 55 which now take the form of card modules 64.

Fig. 9 shows a particular application of the process elucidated by way of example on the basis of **Fig. 1** for the manufacture of a cylindrical formed coil 79 wherein the substrate takes the form of a cylindrical winding support 80 and the wiring or embedding of the wire conductor 20 on the winding support 80 is effected in the course of rotation 81 of the winding support 80 with simultaneous superimposed translation 82 of the wiring device 22.

As **Fig. 10** shows, the winding support 80 may also take the form of a cylindrical extension of a plastic vibrating diaphragm 83 of a loudspeaker unit 84, so that in the manner represented in **Fig. 9** a moving coil 85 is capable of being manufactured such as serves, in combination with a permanent magnet indicated in **Fig. 10**, to form a loudspeaker unit 84.

Fig. 11 shows, by way of another possible application of the process that has been described, a ribbon-cable section 85 with a substrate 86 taking the form of a ribbon cable which, adjoined on both sides by points of separation 87, is provided with substrate recesses 88 arranged in a row

transverse to the longitudinal direction of the substrate 86. On the substrate 86 there are located, arranged parallel to one another and extending in the longitudinal direction of the substrate 86, a plurality of wire conductors 20 which are wired on the substrate 86 in the manner represented by way of example in **Fig. 1**. In this case the wire conductors 20 are guided away in the region of the points of separation 87 via the substrate recesses 88. The points of separation serve for the definition of predetermined ribbon-cable pieces 89, whereby the substrate recesses 88 are then arranged in each instance at one end of a piece of ribbon cable. In particularly favourable manner this results in contacting possibilities for connector plugs or connector sockets with the wire conductors 20 without the wire conductors having firstly to be exposed for this purpose. The substrate recesses 88 are introduced into the substrate 86 in a stamping process with an appropriately formed punch tool, whereby as a result of the spacing of the stampings the spacing of the points of separation 87 is preset. Subsequently the appropriately prepared continuous substrate is covered with the wire conductors 20, whereby in this case a number of wiring devices corresponding to the number of wire conductors 20 are arranged above the substrate which is moved longitudinally.

CLAIMS

1. Process for the wiring of a wire-shaped conductor on a substrate by means of a wiring device acting upon the wire conductor with ultrasound,
characterised in that
the wire conductor (20) is subjected to the action of ultrasound in a direction transverse to the wiring plane (28) and the transverse movement (24) of the wiring device (22) generated by the ultrasonic loading is superimposed on the wiring movement (29) extending in the wiring plane (28).

2. Process according to Claim 1,
characterised in that
the transverse movement (24) takes place along a transverse-movement axis that is variable as regards its angle in relation to the axis of the wiring movement (29).

3. Process according to Claim 1 or 2,
characterised in that
the ultrasonic frequency and/or the angle between the axis of the wiring movement (29) and the transverse-movement axis (24) is varied as a function of the desired depth of penetration of the wire conductor (20).

4. Process according to one or more of the preceding claims,
characterised in that
a final coil region (44) and an initial coil region (43) of a coil (41) which is formed on the substrate (21) by the wiring are guided away via a substrate recess (45).

5. Process according to Claim 4, characterised in that the ultrasonic loading of the wire conductor (20) is interrupted in the region of the substrate recess (45).

6. Process according to one or more of the preceding claims, characterised in that for the purpose of crossing a wire section that has already been wired the ultrasonic loading of the wire conductor (20) is interrupted in the crossing region (57) and the wire conductor (20) is guided in a crossing plane that is spaced in relation to the wiring plane (28).

7. Application of the process according to one or more of Claims 1 to 6 for the manufacture of a card module (64) having a substrate (55), a coil (50) wired on the substrate and a chip unit (58) connected to the coil, whereby in a wiring phase a coil (50) having an initial coil region (51) and a final coil region (52) is formed on the substrate (55) by means of the wiring device (22) and in a subsequent connection phase a connection is implemented between the initial coil region (51) and the final coil region (52) to terminal areas (59) of the chip unit (58) by means of a connecting device (60).

8. Process according to Claim 7, characterised in that the substrate consists of a fleece-type material, in particular paper or cardboard, and the connection which is made in the course of the wiring is effected by means of a layer of adhesive disposed between the wire conductor (20) and the surface of the substrate.

9. Process according to Claim 7 or 8, characterised in that the connection of the initial coil region (51) and of the final coil region (52) to the terminal areas (59) of the chip unit (58) is effected by means of a thermocompression process.

10. Process according to one of Claims 7 to 9, characterised in that the manufacture of a plurality of card modules (64) takes place simultaneously in such a way that in a supply phase a plurality of substrates (55) combined to form a yield (70) are supplied to a production device (72) comprising a plurality of wiring devices (22) and connecting devices (60), subsequently in the wiring phase a plurality of coils (50) are formed simultaneously on substrates (55) arranged in a row, then in the connection phase a plurality of chip units (58) are connected via their terminal areas (59) to the coils (55), and finally in a separation phase a separation of the card modules (64) from the composite yield takes place.

11. Application of the process according to one or more of Claims 1 to 6 for the manufacture of a rotationally symmetrical formed coil, characterised in that the wire conductor (20) is wired on a substrate taking the form of a winding support (80) and rotating relative to the wiring device (22).

12. Process according to Claim 11, characterised by the manufacture of a moving coil of a loudspeaker unit which is integrally connected to a vibrating diaphragm.

13. Application of the process according to one or more of Claims 1 to 6,
characterised in that
a number of wiring devices (22) corresponding to the number of cable conductors desired are arranged transverse to the longitudinal axis of a ribbon-shaped substrate (86) and a relative movement between the substrate (86) and the wiring devices (22) takes place in the direction of the longitudinal axis of the substrate (86).

14. Device for the wiring of a wire-shaped conductor on a substrate in accordance with the process according to one or more of Claims 1 to 6, comprising a wire guide (23) and an ultrasonic generator (34), the ultrasonic generator (34) being connected to the wire guide (23) in such a way that the wire guide (23) is stimulated to execute ultrasonic vibrations in the direction of the longitudinal axis.

15. Device according to Claim 14,
characterised in that
the wire guide (23) comprises a wire-guidance capillary (37) which at least in the region of a wire-guide nozzle (30) extends in the wire guide (23) parallel to the longitudinal axis.

16. Device according to Claim 15,
characterised in that
the wire guide (23) comprises, spaced from the wire-guide nozzle (30), at least one wire-supply channel (38, 39) extending obliquely in relation to the longitudinal axis of the wire guide.

17. Device according to one or more of Claims 14 to 16,
characterised in that

the ultrasonic generator (34) is arranged coaxially with respect to the wire guide (23).

18. Device for implementing the process for the manufacture of a card module according to one or more of Claims 7 to 10 by making use of a device according to one or more of Claims 14 to 17, comprising

a yield supply station (65) for supplying a plurality of substrates (55) arranged in a yield (70),

a wiring station (66) with a plurality of wiring devices (22) arranged in a row transverse to the production direction,

an assembly station (67) with at least one assembly device (76) for equipping the individual substrates (55) with a chip unit (58) and

a connection station (68) with at least one connecting device (77) for connecting the chip units to an initial coil region (51) and to a final coil region (52) of the coils (50) which are formed on the substrates (55) by the wiring devices (22).

ABSTRACT

Process and device for the wiring of a wire-shaped conductor on a substrate by means of a wiring device acting upon the wire conductor with ultrasound, wherein the wire conductor (20) is subjected to the action of ultrasound in a direction transverse to the wiring plane (28) and the transverse movement (24) of the wiring device (22) generated by the ultrasonic loading is superimposed on the wiring movement (29) extending in the wiring plane (28).

(Fig. 1)

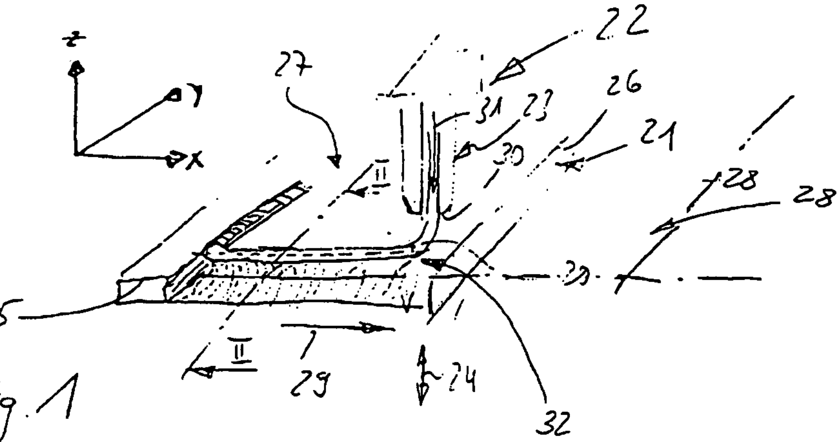

Fig. 1

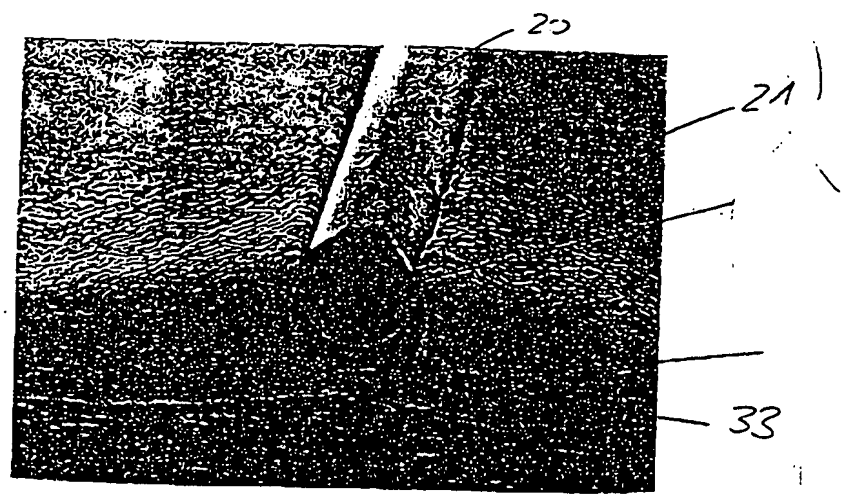

FIG. 2

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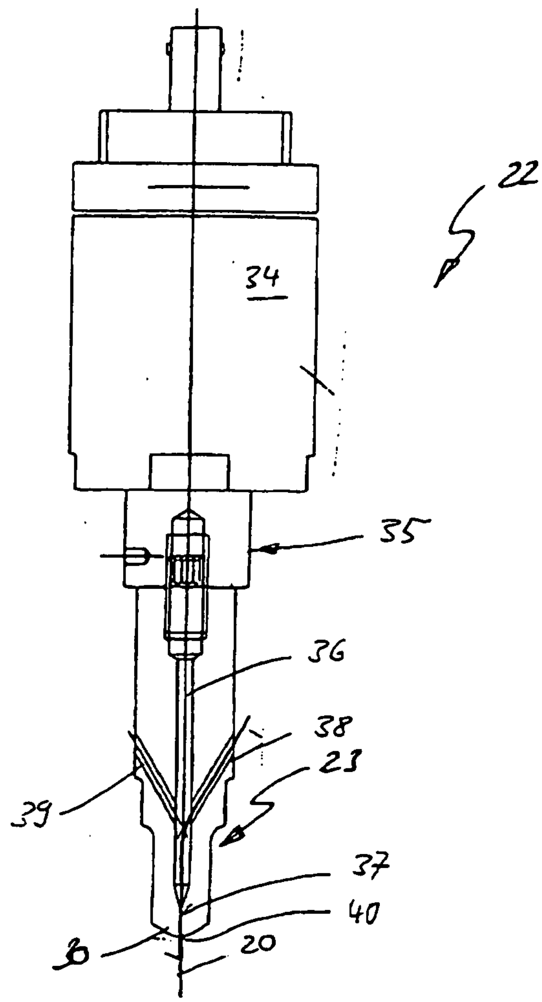

FIG.3

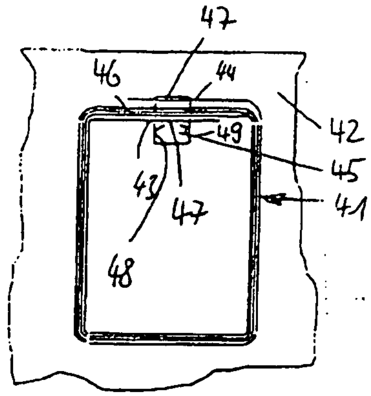

FIG. 4

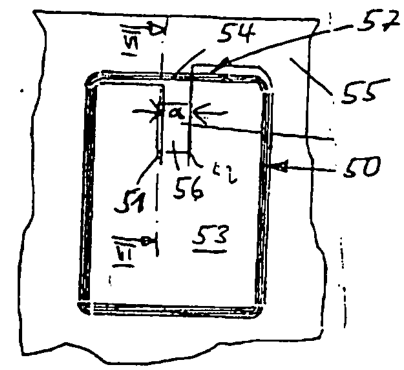

FIG. 5

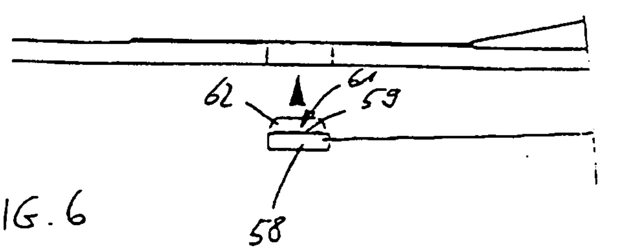

FIG. 6

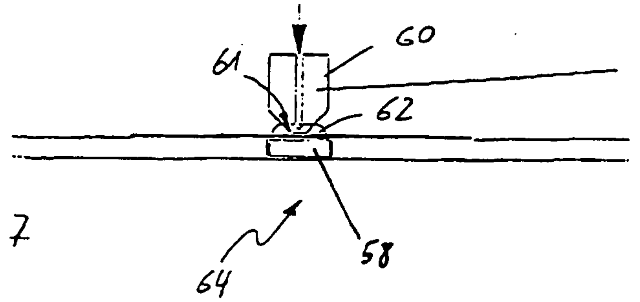

FIG. 7

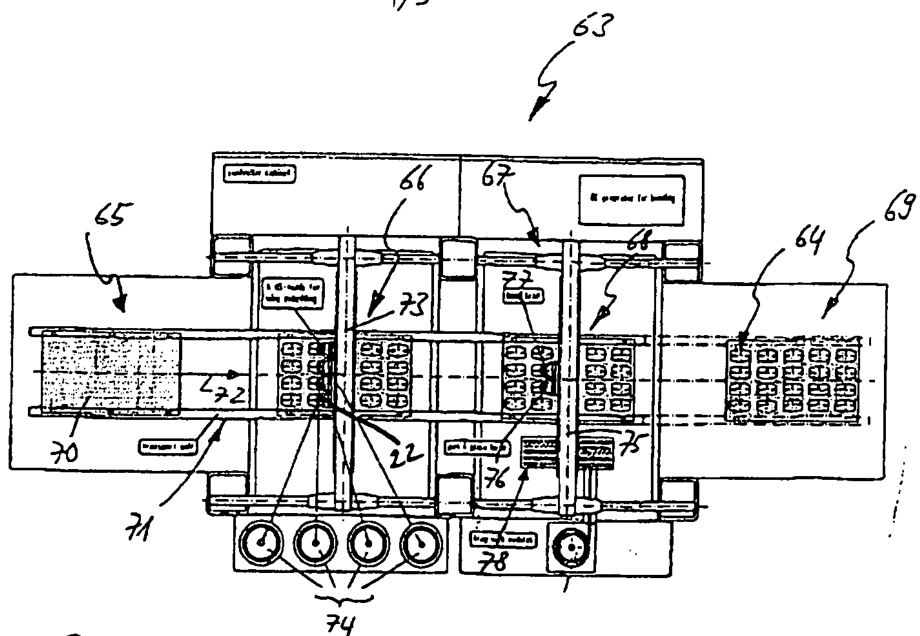

FIG. 8

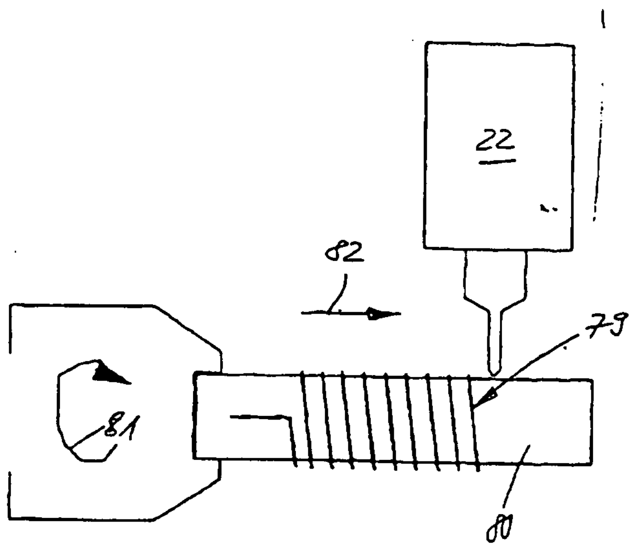

FIG. 9

D

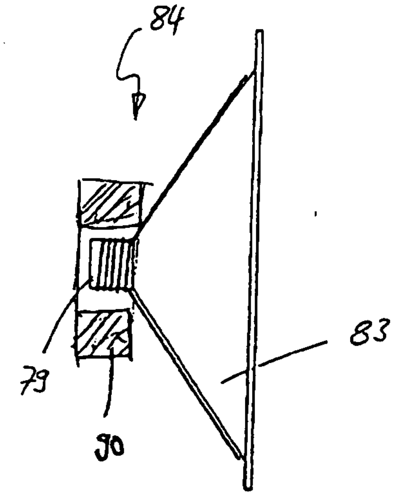

FIG. 10

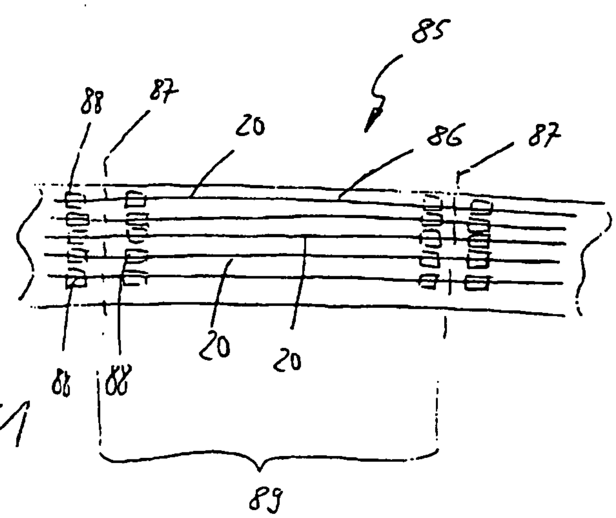

FIG. 11